Alterations of Renal and Urinary Tract Function

Chapter 29
Urinary Tract Obstruction

- Urinary tract obstruction is an interference with the flow of urine at any site along the urinary tract
  - The obstruction can be caused by an anatomic or functional defect
Urinary Tract Obstruction

- Severity based on:
  - Location
  - Completeness
  - Involvement of one or both upper urinary tracts
  - Duration
  - Cause
Urinary Tract Obstruction

- Ureteropelvic valve
- Ureteropelvic stricture
- Fibrous band
- Stenosis
- Ureteral orifice
- Urethral sphincter muscle in urogenital diaphragm
- Posterior vesicoureteral valve
- Urethral stenosis
- Urethral sphincter muscle
- Prostate hypertrophy
- Posterior vesicourethral valve
- Dysplasia-agenesis of ureter
- Hydrocephalus
- Polycystic kidney
Urinary Tract Obstruction

- Compensatory hypertrophy
  - Obligatory growth
  - Compensatory growth
- Post-obstructive diuresis
Upper Urinary Tract Obstruction

- Kidney stones
  - Calculi or urinary stones
    - Masses of crystals, protein, or other substances that form within and may obstruct the urinary tract
  - Risk factors
    - Gender, race, geographic location, seasonal factors, fluid intake, diet, and occupation
  - Kidney stones are classified according to the minerals comprising the stones
Pathophysiology

- 80% of kidney stones are composed of calcium with oxalate or phosphate.
- Kidney stones are the result of crystallization of stone-forming salts that separate from the urine.
- Affects 5% of the population.
- Stones vary in size from microscopic to one-inch.
- **Kidney Stones**
- **Uteroscopic stone removal**
Kidney Stone Formation

- Supersaturation of one or more salts
  - Presence of a salt in a higher concentration than the volume able to dissolve the salt
- Precipitation of a salt from liquid to solid state
  - Temperature and pH
- Growth into a stone via crystallization or aggregation
Kidney Stone Formation

- Other factors affecting stone formation
  - Crystal growth-inhibiting substances
  - Particle retention
  - Matrix

- Stones
  - Calcium oxalate or calcium phosphate
  - Struvite stones
  - Uric acid stones
Kidney Stones

- **Manifestation**
  - Renal colic

- **Evaluation**
  - Stone and urine analysis
  - Intravenous pyelogram (IVP) or kidney, ureter, bladder x-ray (KUB)
  - Spiral abdominal CT

- **Treatment**
  - High fluid intake, decreasing dietary intake of stone-forming substances, stone removal
Lower Urinary Tract Obstruction

- Neurogenic bladder
  - Dyssynergia
    - Detrusor hyperreflexia
    - Detrusor areflexia
  - Obstruction
  - Low bladder wall compliance
Tumors

- Renal tumors
  - Renal adenomas
  - Renal cell carcinoma (RCC)
- Bladder tumors
  - Transitional cell carcinoma
  - Gross, painless hematuria
  - Most common in males older than 60 years
Urinary Tract Infection (UTI)

- UTI is inflammation of the urinary epithelium caused by bacteria
- Acute cystitis
- Painful bladder syndrome/interstitial cystitis
- Interstitial cystitis
- Acute and chronic pyelonephritis
Urinary Tract Infection (UTI)

- Most common pathogens
  - *Escherichia coli*

- Virulence of uropathogens
  - Host defense mechanisms
Urinary Tract Infection (UTI)

- **Acute cystitis**
  - Cystitis is an inflammation of the bladder
  - **Manifestations**
    - Frequency, dysuria, urgency, and lower abdominal and/or suprapubic pain
  - **Treatment**
    - Antimicrobial therapy, increased fluid intake, avoidance of bladder irritants, and urinary analgesics
Urinary Tract Infection (UTI)

- Interstitial cystitis
  - Nonbacterial infectious cystitis
  - Manifestations
    - Most common in women 20 to 30 years old
    - Bladder fullness, frequency, small urine volume, chronic pelvic pain
  - Treatment
    - No single treatment effective, symptom relief
Urinary Tract Infection (UTI)

- **Pyelonephritis**
  - **Acute pyelonephritis**
    - Acute infection of the renal pelvis interstitium
      - Vesicoureteral reflux, *E. coli*, *Proteus*, *Pseudomonas*
  - **Chronic pyelonephritis**
    - Persistent or recurring episodes of acute pyelonephritis that leads to scarring
    - Risk of chronic pyelonephritis increases in individuals with renal infections and some type of obstructive pathologic condition
Chronic Pyelonephritis

From Damjanov I. Pathology for the health professions, ed 3, St Louis, 2006, Saunders.
Glomerular Disorders

- The glomerulopathies are disorders that directly affect the glomerulus
- Urinary sediment changes
  - Nephrotic sediment
  - Nephritic sediment
  - Sediment of chronic glomerular disease
Glomerular Disorders

- Glomerular disease demonstrates a sudden or insidious onset of hypertension, edema, and an elevated blood urea nitrogen (BUN)
- Decreased glomerular filtration rate
  - Elevated plasma creatinine, urea, and reduced creatinine clearance
Glomerular Disorders

- Glomerular damage causes a decreased glomerular membrane surface area, glomerular capillary blood flow, and blood hydrostatic pressure.
Glomerular Disorders

- Increased glomerular capillary permeability and loss of negative ionic charge barrier result in passage of plasma proteins into the urine
- Resulting hypoalbuminemia encourages plasma fluid to move into the interstitial spaces
  - Edema
Glomerular Disorders

- Glomerulonephritis
  - Inflammation of the glomerulus
    - Immunologic abnormalities (most common)
    - Drugs or toxins
    - Vascular disorders
    - Systemic diseases
    - Viral causes
  - Most common cause of end-stage renal failure
Glomerulonephritis

Mechanisms of injury

◦ Deposition of circulating soluble antigen-antibody complexes, often with complement fragments
◦ Formation of antibodies against the glomerular basement membrane
Glomerulonephritis

- Acute poststreptococcal glomerulonephritis
- Rapidly progressing glomerulonephritis
  - Antiglomerular basement membrane disease (Goodpasture syndrome)
- Chronic glomerulonephritis
Glomerulonephritis
Nephrotic Syndrome

- Excretion of 3.5 g or more of protein in the urine per day
- The protein excretion is caused by glomerular injury
- Findings
  - Hypoalbuminemia, edema, hyperlipidemia, and lipiduria, and vitamin D deficiency
Nephrotic Syndrome

- Membranous glomerulonephritis
- Focal glomerulosclerosis
- Minimal change disease (lipoid nephrosis)
Acute Renal Failure (ARF)

- Prerenal acute renal failure
  - Most common cause of ARF
  - Caused by impaired renal blood flow
  - GFR declines because of the decrease in filtration pressure
Acute Renal Failure (ARF)

- **Intrarenal acute renal failure**
  - Acute tubular necrosis (ATN) is the most common cause of intrarenal renal failure
    - Postischemic or nephrotoxic
    - Oliguria

- **Postrenal acute renal failure**
  - Occurs with urinary tract obstructions that affect the kidneys bilaterally
Acute Renal Failure (ARF)

- Oliguria phase
- Diuretic phase
- Recovery phase
Chronic Renal Failure

- Chronic renal failure is the irreversible loss of renal function that affects nearly all organ systems
- Stages
  - Chronic renal insufficiency
  - Chronic renal failure
  - End-stage renal failure
Chronic Renal Failure

- Proteinuria and uremia
- Creatinine and urea clearance
- Fluid and electrolyte balance
  - Sodium and water balance
  - Phosphate and calcium balance
  - Potassium balance
  - Acid-base balance
Chronic Renal Failure

- Alterations seen in following systems:
  - Musculoskeletal
  - Cardiovascular and pulmonary
  - Hematologic
  - Immune
  - Neurologic
Chronic Renal Failure

- Gastrointestinal
  - Alteration in protein, carbohydrate, and lipid metabolism
- Endocrine and reproduction
- Integumentary